Anatomy of a Work Truck





Understand the Terms, Lingo and Processes Used by OEMs, Upfitters and Fleets

December 2013

Doyle Sumrall Managing Director







ABOUT THE NTEA

Established in 1964, NTEA, the Association for the Work Truck Industry, represents approximately1,600 companies that manufacture, distribute, install, sell and repair commercial trucks, truck bodies, truck equipment, trailers and accessories. Buyers of work trucks and the major commercial truck chassis manufacturers also belong to the Association. The NTEA provides in-depth technical information, education and member programs and services, and produces The Work Truck Show[®]. The Association maintains its headquarters in suburban Detroit and a government relations office in Washington, DC. For more information, call 1-800-441-6832 or visit <u>www.ntea.com</u>.

About the Green Truck Association

The GTA is an affiliate division of the NTEA. Its mission is to improve the efficiency and productivity of work trucks through the development and deployment of strategies to reduce diesel and gasoline consumption and the associated environmental impacts. To learn more, visit <u>www.greentruckassociation.com</u>.



Class 1-8 U.S. Retail Sales



U. S. Department of Energy









Complexities of the Supply Chain





Vocational Demographics



U. S. Department of Energy



287 Fleet Respondents Source: 2013 NTEA Fleet Purchasing Outlook



Fuel-saving Strategies



U.S. Department of Energy



Source: 2013 NTEA Fleet Purchasing Survey

THE ASSOCIATION FOR THE WORK TRUCK INDUSTRY

OEM Perspective



- CNG is a prime focus
- An order of magnitude breakthrough is needed for electric hybrid and/or electric drive
- Diesel will be with us for a very long time and we can expect breakthroughs in this engine technology
- Fleets / users see life-cycle cost as the prime acquisition criterion





ANATOMY OF A WORK TRUCK

Understanding the terms and lingo used by OEMs and Fleets







America's truck population is estimated to be more than 90 million vehicles with 4 million being vocational vehicles. Employing more than 175,000 Americans, the truck body and equipment industry produces \$15 billion+ in annual sales. Adding chassis manufacturers to this already-substantial figure creates a total market of \$67 billion. Although these figures represent only a small percentage of the multibillion-dollar transportation industry, our country's economy and productivity depend largely on this highly specialized trade.



ties



Unlike mass-produced assembly-line passenger cars and trucks, commercial vehicles are primarily designed and produced individually, on a custom-order basis. Their diverse applications, limited volume, and nearly limitless body and equipment variations dictate this method of production.



Where a Work Truck Starts



U.S. Department of Energy



Each commercial vehicle originates at the assembly plant of one of the world's truck/truck chassis manufacturers. Approximately 15 companies produce light- and medium-duty trucks, truck chassis, and cab-chassis (basically, a cab, frame and drive -train) suitable for completion as commercial vehicles. Through truck dealerships, these products are supplied to truck body and equipment firms for final assembly and installation before delivery to the customer or end-user.







WB = Chassis Wheel Base

CA/CT = Cab to Axle/or Cab to Center of Tandem

CB = Cab to Body Clearance

AC = Front Axle to Back of Cab (WB - CA = AC)

or (BBC - BA = AC)

BA = Front Bumper to Front Axle

BBC = Front Bumper to Back of Cab

BL = Body Length



Carrying Loads



U. S. Department of Energy



CW = Chassis Curb Weight CWR = Chassis Curb Weight - Rear GAWR.F = Gross Axle Weight Rating - Front GAWR.R = Gross Axle Weight Rating - Rear GVWR = Chassis Gross Vehicle Weight Rating There are also many truck axle-drive combinations to meet different hauling and terrain conditions. The following drawings illustrate the most common ones and their accepted names. *Shaded wheels and axles are the driving units*. Dual tires are considered as one driving wheel.



4x2 – 4 wheels, 2 driven 1 driving axle



6x2 – 6 wheels, 2 driven 1 driving axle with pusher axle



4x4 – 4 wheels, 4 driven 2 driving axles



6x4 – 6 wheels, 4 driven 2 driving axles



6x2 – 6 wheels, 2 driven 1 driving axle with tag axle



6x6 – 6 wheels, 6 driven 3 driving axles 14



Adding Axles





The dead axle is installed either ahead of the live axle or behind it, depending on the truck and the operation. When installed behind the live axle it is called a *tag axle*. *When installed in front of* the driving axle it is called a *pusher axle*.



Common Components

Components of commercial vehicles range from tiny gears and parts to larger products such as cranes, snowplows and liftgates. Here are some common truck equipment and accessories:

Aerial Devices Alarms **Brake Components Bumpers** Cabs Cargo Control Equipment Cranes **Drive-line Components** Fifth Wheels Fuel Tanks Hardware Hitches Hoists Hydraulic Components

Lift Axles Lift Gates/Platforms Lights Power Take-Offs (PTOs) Pumps Racks Ramps **Refrigeration Systems Refuse Equipment** Shelving/Bins **Snowplows** Toolboxes Winches





U.S. Department of Energy



Making a Chassis a Work truck



Clearance Side Marker Refrigeration Door Lamps Lamps Identification Unit Lamps Van Body lining/ insulation Roll-Up Door Cargo Control Equipment Hardware Rub Rails Backup Lamp 00 0.0 Stop and Chassis Cab Signal Lamps Toolbox D Stirrup Steps Mud Flaps Power Take-Off **Elevating Tail Gate**

Depending on its application, a commercial truck can require a few basic pieces of equipment (such as a snowplow or a stake body) or a wide variety of components. It is the distributor's role to combine and install all of these components, supplied by their various manufacturers, to complete the truck for its specific use.



Green Fleet & Truck Efforts





U.S. Department of Energy

DESIGN AND ENGINEERING OF A WORK TRUCK

THE ASSOCIATION FOR THE WORK TRUCK INDUSTR

Motor Vehicle Certification

U.S. Department of Energy

Understanding Multi-Stage Vehicle Certification and Labeling Requirements

THE ASSOCIATION FOR THE WORK TRUCK INDUSTRY

Certify to What?

- Certify that the motor vehicle conforms to all applicable Federal Motor Vehicle Safety Standards (FMVSSs).
- 49 CFR Part 571 FMVSS
- 61 FMVSS
- 48 FMVSS applicable to "Trucks"

Law & Regulations

U. S. Department of Energy

Law: Title 49, United States Code Section 30115 – Certification of Compliance

National Highway Traffic Safety Administration (NHTSA) Regulations:

- 49 CFR Part 567-Certification
- 49 CFR Part 568-Vehicle manufactured in two or more stages

Who is Required to Certify?

Final stage manufacturers, intermediate manufacturers and alterer of motor vehicles and motor vehicle equipment

Cities

What and Why of Weight **Distribution**

BRI	DGE	GROSS	WEIGHT	FORMUL

Bridge Table A

$wla W = 500 \left(\frac{LN}{110} + 12N + 36\right) \text{ modified}^{10}$

tween the extremes of any group of 2 or	Ма	ximum load	l in pounds c					
more consecutive axles	2 axles	3 axles	4 axles	5 axies	6 axles	7 axles	8 axles	MFD BY: XYZ TRUCK EQUI
	34,000							FARMINGTON HILLS,
5	34,000							DATE OF MEDING IN ME
5	34,000							DATE OF MERIMU. 10 YF
7	34,000		i-					GVMR: 5443 KG/ 12
8 and less	34,000	34,000						diffic diffic hu (
More than 8	38,000	42,000						GAWR-FRONT:
	39,000	42,500						2 177 10 / 4 8
0	40,000	43,500						2,117 NO (4,01
1		44,000	60.000					WITH 215/85 R 16 E
12		45,000	50,000					
4		46 500	51,500					<u>16 X 6.5 J</u> RIMS, @ 4
5		47,000	52,000					(DSI) COLD
6		48,000	52,500	58.000				ron ootb
7		48,500	53,500	58,500				GAWR-INTERMEDIATE(1):
8		49,500	54,000	59,000				KO (
.9		50,000	54,500	60,000				KG (
D Examp	le	51,000	55,500	60,500	66,000			WITH
Jan		51,500	56,000	61,000	66,500			
2		52,500	56,500	61,500	67,000			RIMS, @
3		53,000	57,500	62,500	68,000			1 0010
4		54,000	58,000	63,000	68,500	74,000	·	PSI) COLD
5		54,500	58,500	63,500	69,000	74,500		GAWR-INTERMEDIATE(2)
.6		55,500	59,500	64,000	69,500	75,000		diant internicourie(2).
7		56,000	60,000	65,000	70,000	75,500		KG (
8		57,000	60,500	65,500	71,000	76,500	82,000	WITH
9		57,500	61,500	66,000	71,500	77,000	82,500	WITH
1		58,500	62,000	67,500	72,000	77,500	83,000	RIMS @
2		60,000	63 500	68,000	72,500	78,500	84 500	1
3			64,000	68,500	74.000	79,000	85,000	(PSI) COLD
4			64.500	69.000	74.500	80,000	85,500	GAWR-REAR.
5			65,500	70,000	75,000	80,500	86,000	Contra neral.
6	E.	contion	(66,000)	70,500	75,500	81.000	86,500	3,901 KG (8,60
	EX.	ception	{ 66,500 }	71,000	76,000	81,500	87,000	MITH OLE OF
8			(67,500)	71,500	77,000	82,000	87,500	WITH 215/85 R 16 E
			68,000	72,500	77,500	82,500	88,500	16 X 16 5 J RIMS @ 4
0			68,500	73,000	78,000	83,500	89,000	HIND, W
			69,500	73,500	78,500	84,000	89,500	(65 PSI) COLD I
2			70,000	74,000	79,000	84,500	90,000	
3			70,500	75,000	80,000	85,000	90,500	THIS VEHICLE HAS BEEN COMPLETED IN ACCO
4			71,500	75,500	80,500	85,500	91,000	THE PRIOR MANUFACTURERS' IVO WHERE A
.)		********	72,000	76,000	81,000	86,000	91,500	THE VEHICLE CONFORME TO ALL ADDITION
0			72,500	76,500	81,500	87,000	92,500	THIS VEHICLE CONFORMS TO ALL APPLICAB
0			73,500	77,300	82,000	87,500	93,000	MOTOR VEHICLE SAFETY STANDARDS, JAND
0			74,000	78,000	83,000	88,000	93,500	THEFT PREVENTION STANDARDS JE ADDI LCARI
·0			74,500	78,500	83,500	88,500	94,000	THE FERENCE OF A CHARLEN DO, IF AFTERNOL
······			75,500	79,000	84,000	89,000	94,500	MO03 YR.
2			76,500	80,000	85,000	09,500	95,000	VEHICLE DENTIFICATION NU
3			77 500	81,000	86,000	91,000	96,500	VEHICLE IDENTIFICATION NO
4			78 000	81 500	86,500	91 500	97,000	1A34567891234560
5			78,500	82 500	87,000	92 000	97 500	
6	Interet	to Gross	79,500	83.000	87.500	92,500	98.000	VEHICLE TYPE:
57	intersta	ie Gross	80,000	83,500	88,000	93,000	98,500	
	weigh	t Limit	2	84,000	89,000	94,000	99,000	TRUCK
9			L	85,000	89,500	94,500	99,500	
0				85 500	00.000	04 000	100 600	

** The following loaded vehicles must not operate over H15-44 bridges: 3-52 (5 axles) with wheelbase less than 2-51-2 (5 axle) with wheelbase less than 45 feet; 3-3 (6 axle) with wheelbase less than 45 feet; and 7-, 8-, and 9-axle meanwhere of photohese WHY? For compliance with:

Wheel/tire capacities **Axle capacities – GAWRs** Vehicle capacity – GVWR State weight laws **Federal weight laws FMVSS**

U.S. Department of Energy

8 axles	MFD BY: XYZ THUCK EQUIPMENT
	FARMINGTON HILLS, MI
	DATE OF MFR:MO. 10 YR. 2009
	GVWB: 5.443 KG (12.000 JB)
	GAWR-FRONT:
	2,177 KG (4,800 I B)
	WITH 215/05 H TO E TIRES,
	16 X 6.5 J RIMS, @ 480 KPA
	/
	(PSI) COLD
	GAWR-INTERMEDIATE(1);
	K0 / 10)
	Kū (LB)
	WITH TIRES.
	PIMC @ KDA
	(PSI) COLD
	GAWB-INTERMEDIATE(2)
	draft-artenniebinte(z).
82.000	KG (LB)
82,000	WITH TIRES
83.000	Title,
83,500	RIMS, @KPA
84,500	(PSI) COLD
85,000	CANNO DEAD
86,000	GAWR-REAR:
86,500	3,901 KG (8,600 LB)
87,000	WITH DIFIER DIFE TIDES
87,500	WITH 215/65 H 16 E IINES,
88,500	16 X 16.5 J RIMS, @ 450 KPA
89,000	
90,000	UOOOULDDUAL
90,500	THIS VEHICLE HAS BEEN COMPLETED IN ACCORDANCE WITH
91,000	THE PRIOR MANUFACTURERS' IVO WHERE APPLICABLE
91,500	TUIC VEUICIE CONCODINC TO ALL ADDI ICADI E CEDEDAL
91,000	MOTOR VEHICLE OUT OTHING TO ALL AF FLIVADLE FEDERAL
93,500	MUTUR VEHICLE SAFETY STANDARDS, JAND BUMPER AND
94,000	THEFT PREVENTION STANDARDS, IF APPLICABLE IN EFFECT IN:
94,500 1	MO 03 YB 2009
95,000 1	
95,500	VEHICLE IDENTIFICATION NUMBER:
97,000	1A34567891234560
97,500	WELLIOL F TROPE
98,000 1	VEHICLE TYPE:
98,500 1	TRUCK
99,000 1	THOUR
99,500	
100.300	

U. S. Department of Energy

CRITICAL ELEMENTS OF CERTIFICATION

Payload analysis Weight Distribution FMVSS Compliance Analysis Drive and Duty Cycle

Payload Analysis

U.S. Department of Energy

<u>Component</u>	<u>Weight</u>
Chassis	5,906 lbs / GVWR 9,800 lbs
Body	1,355 lbs
Winch	150 lbs
Crane	630 lbs
Cargo	1.300 lbs (Customer Requested)
Passengers	450 lbs

Space Weight Safety Vertical CG

Basic Principles

Combined Center of Gravity

When a group of objects are combined they have a combined Center of Gravity.

<u>What</u> and Why of Weight Distribution

U. S. Department of Energy

WHAT – weight distribution is the amount of the total vehicle weight imposed on the ground at an axle, group of axles, or an individual wheel. The weight on a truck must be distributed on the axles to comply with the chassis manufacturer's axle ratings and the weight laws.

In the examples above, having the correct wheelbase on the chassis and placing the bodies and loads in the proper place will assure that the axles are loaded correctly. Doing a weight distribution will tell us that we can achieve the proper axle loadings before building the truck.

Moments give us a way to combine a number of components or items to calculate a center-ofgravity for them as a group. When we know the center-of-gravity distance for all of the items combined, we can calculate the weight on each axle. (Total Moment)

Dt = Dc*Wc + Db*Wb - Dw*Ww + Dg*Wg Wc + Wb + Ww + Wg (Total Weight = Wt)

Weight Distribution

- Perform weight distribution using maximum net payload to determine if GAWRs are exceeded. If so, reduce payload accordingly and revise payload analysis.
- Both payload analysis and weight distribution need to be kept as part of certification documentation.

Vehicles 10,000 lbs GVWR and Under

U. S. Department of Energy

Some example restrictions due to barrier test requirements:

- Maximum vertical Center-of-Gravity for the body
- Maximum added equipment weight
- Curb weight of the finished vehicle
- Minimum cab-to-body clearance

Final Stage Certification Label

U. S. Department of Energy

For Chassis Cabs, Cutaways, Chassis Cowls and Strip Chassis

Final Stage Certification Label

Clean Cities

For Chassis Cabs, Cutaways, Chassis Cowls and U.S. Department of Energy Strip Chassis Over 10,000 lbs

Hierarchy of Application

Electric Vehicles Hybrid Vehicles Gaseous Fuel Aerodynamics High Efficiency Engines Component Electrification Telematics Driver Involvement Weight Reduction Idle Reduction

Pyramid of Solutions

% of Fleets See Factor as High Importance

GRANTS

Source: *2013 NTEA Fleet Purchasing Outlook* (Acquiring fleets)

Using Analysis and Tools to Understand Payback

Drive & Duty Cycle Data

Life Cycle Cost

- UNDERSTANDING USE & NEEDS
- COMPARING TECHNOLOGY & FUELS
- DEVELOPING BUY-IN
- REFINING RESULTS

Using Analysis and Tools to Understand Payback

U.S. Department of Energy

Drive and Duty Cycle Data

Validation and Insights

Green Fleet Tool

imple Payback Calculator														
				Gasoline			Diesel					Compressed	Liquefied	
			Gasoline	PHEV 10-		Diesel	Hydraulic	Biodiesel	Biodiesel	Ethanol	Propane	Natural Gas	Natural	LNG / Diese
	Gasoline	Diesel	HEV	20	EV	HEV	Hybrid	(B20)	(B100)	(E85)	(LPG)	(CNG)	Gas (LNG)	Pilot Ignitio
Light Duty Vehicle Infor														
Vehicle Type	assenger	Car												
Number of LDVs	0	0	0	0	0			0	0	0	0	0		
Annual Mileage	11,900	11,900	11,900	11,900	11,900			11,900	11,900	11,900	11,900	11,900		
Fuel Economy (MPGGE)	27.2	32.6	38.1	38.1	95.2			32.6	32.6	27.2	27.2	27.2		
Fuel Consumption (GGE/100m	3.7	3.1	2.6	2.6	1.1	0.0	0.0	3.1	3.1	3.7	3.7	3.7		
CD Electricity Use (kWh/100mi)				29.0	35.4									
CD Electricity Use (GGE/100mi))			0.9										
CD Gasoline Use (GGE/100mi)				0.2										
PHEV CD Range (miles)				11.0										
Charges per Day				1.0										
Days per Week Driven				5										
Share of CD miles				24%										
Purchase Price (Per Vehicle) \$	19.000	\$ 23,000	\$ 25,000	\$ 32,000	\$ 35,000			\$ 23,000	\$ 23,000	\$ 19,000	\$ 25,000	\$ 26,000		
Incentive (Per Vehicle)	,	\$	\$	\$	\$			\$	\$	•,	\$	\$		
Maintananco & Panair (Dar M	0.49	\$ 0.49	\$ 0.49	\$ 0.17	\$ 0.47				¢ 0.49	\$ 0.49	\$ 0.49	\$ 0.49		
Maintenance & Repair (Per m s	0.10	J U.10	÷ 0.18	• •.17	3 0.17			• •	J U.15	3 0.10	\$ 0.10	÷ 0.16		
Heavy Duty Venicle Info	nale Unit	Short-Haul	Truck											
Number of HDVs	0	0			0	0	0	0	0	0	0	0	0	
	46 500	46 500				46 500	46 500	46 500	46 500	46 500	46 500	46 500	46 500	16.
	10,500	10,500				10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,1
	5.3	0.3			0.0	41.0	6.1	0.0	6.3	0.3	5.3	0.0	5.4	
ruei Consumption (GGE/100m	19.0	15.9			0.0	2.4	12.3	0.0	15.9	15.9	19.0	0.0	18.7	1
Fuel Consumption (DGE/100m	16.9	14.1			0.0	2.2	10.9	0.0	14.1	14.1	16.9	0.0	16.6	1
CD Electricity Use (kWh/100mi)	94.1				0.0									
DEF Use (% of fuel consumpt	0%	3%			0%	0%	3%	3%	3%	3%	0%	0%	0%	
Purchase Price (Per Vehicle) \$	-	\$ 75,000			s -	\$ -	\$115,000	\$ 135,000	\$ 75,000	\$ 75,000	ş -	s -	\$130,000	\$ 130,0
Incentive (Per Vehicle) \$	-	\$ -			s -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	s -	\$ -	\$
					*	£ 0.00	£ 0.00	¢ 0.00	£ 0.20	¢ 0.00	£ 0.20	¢ 0.00	£ 0.00	<u> </u>

For details, contact aburnham@anl.gov

Hybrid Work Truck Payback Calculator

U.S. Department of Energy

Hybrid Work Truck Payback Worksheet

High frequency stop and go driving 15+ cycles / hour)

Medium frequency stop and go driving conditions (8-14 cycles / hr.)

Low frequency stop and go driving conditions (7 or fewer cycles per hour)

Conventional Vehicle Usage Profile:

Average vehicle use per year (Days)

Projected vehicle life (Years)

Average Hours of vehicle use per day

Operating Profile:

- Hours per day -- Stop / Go Hours per day -- Open highway
- Hours per day -- Idle time Hours per day -- Shutdown

4.3

2

235

13.5

8.1

2.3 0.1 4.7 1

(Maximum 15 years)

Stop & Go Driving Profile: (Select one) (Place an "X" in appropriate block)

Fuel Consumption Data -- Current Application

Average gallons of fuel consumed per hour -- In Transit Average gallons of fuel consumed per hour -- Idling Average gallons of aux engine fuel consumed per hour Average cost of fuel (per gallon)

х

Hybrid Projected Operating Cost Reductions:

Idle reduction: Auxiliary engine use reduction

2
1.8
0.5
5.15

Hours per day (average)

Hours per day (average)

Data Source © 2013 Odyne Systems, LLC All rights reserved

Hybrid Work Truck Payback Calculator

U.S. Department of Energy

Hybrid Work Truck Payback Worksheet

8

in year

Hybrid Projected Maintenance Cost Differential:

Brakes -- <u>Current application</u> demand cost per year Engine -- <u>Current application</u> demand cost per year Auxiliary engine savings / year (reduced use or elimination)

Hybrid energy storage system maintenance cost (battery replacement, accumulator rebuild, etc.)

Projected Hybridization Cash Flows per year

Year	Transit Fuel Savings		ransit Fuel Savings Idle Fuel Savin		vings Aux Fuel Savings			Maintenance Cost Differential			Total \$ by
	Gallons	\$	Gallons	\$	Gallons	\$	Brakes	Engine	Auxiliary	Maint.	Year
1	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
2	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
3	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
4	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
5	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
6	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
7	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
8	432	2,227	1,011	5,204	235	1,210	180	1,211	500	-1,000	9,532
9	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
10	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
11	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
12	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
13	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
14	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
Total Fuel	6,054		14,147		3,290						
Total Dollars		31,176		72,857		16,944	2,516	16,958	7,000	-1,000	146,450
Net present value of total life cycle savings at			5.2%	rate of re	eturn:	\$102,5	92.04				

250

2000

500 1000

Data Source; © 2013 Odyne Systems, LLC All rights reserved

Cities U. S. Department of Energy

Commercial Vehicles In Use Class 3-8 U.S.

(January 2011-September 2013)

U n

i t

S

44

Work Trucks Come in All Shapes and Types

Many Applications

Where should a fleet begin?

U. S. Department of Energy

U.S. Department of Energy

Thank you!

Doyle Sumrall, Managing Director, NTEA (330) 283-2176 doyle@ntea.com